Graphically displayable array 340 has horizontal axis (e.g., x-axis) 302 and vertical axis (e.g., y-axis) 304 and comprises a plurality of data points (e.g., pixels). In one embodiment, the records are divided into groups 306 according to each record's value of the first dividing attribute (e.g., no second dividing attribute is determined). The records of each group 306 are placed according to a first ordering attribute and a second ordering attribute. Ordering arrows 310 and 312 indicate the direction of record placement within each group 306.

In another embodiment, the records are divided into sub-groups 308 according to each record's value of the first dividing attribute and value of the second dividing attribute. The records of each sub-group 308 are placed according to a first ordering attribute and a second ordering attribute. Ordering arrows 310 and 312 indicate the direction of record placement within each sub-group 308.

At step 250, a visual indicator is applied to each record according to the visual indicator attribute. In one embodiment, the visual indicator is a color. In one embodiment, non-linear 256 RGB (red-green-blue) color scale is used for determining the color for each record. In another embodiment, a non-linear gray-scale color scale is used to determine the color for each record. It should be appreciated that any color scale or range, both linear and non-linear, may be used in regard to the present invention. In one embodiment, the value of the visual indicator attribute is normalized

to the range 0 to 1. In one preferred embodiment, the normalization is nonlinear. Then the range 0 to 1 is mapped to a color range.

In one embodiment, where multiple pixel bar charts are used, different attributes are the visual indicator attribute in different bar charts, which enables a user to relate the different coloring attributes and detect partial relationships among the records. In the present embodiment, the dividing and ordering attributes have to stay in the same order:

$$<D_x, D_y, O_x, O_y, C>$$

where $D_x, D_y, O_x, O_y, C \in \{A_1, \ldots, A_k\} \cup \perp$ and D_x/D_y are the dividing attributes in x-/y-direction, O_x/O_y are the ordering attributes in x-/y-direction, and C is the coloring attribute. The element $\perp$ is used if no attribute is specified.

Figure 4 is a flowchart diagram illustrating steps in a process 400 for pixel placement within a sub-group of a pixel bar chart in accordance with an embodiment of the present invention. The pixel placement within one sub-group requires a two-dimensional sort. The present invention provides a heuristic process for pixel placement by partitioning the data set into subsets according to the first ordering attribute (O_x) and the second ordering attribute (O_y).

At step 410, the one-dimensional histograms for O_x and O_y are determined for providing an efficient pixel placement within a single sub-group. The one-dimensional histograms for O_x and O_y are used to determine the ∂-quantiles of O_x and O_y. In one embodiment, if the sub-group under consideration has extension w x h pixels, the $1/w,\ldots,(w-1)/w$-quantities for the partitioning of O_x and the $1/h,\ldots,(h-1)/h$- quantities for the partitioning of O_y are determined. The quantiles are then used to determine the partitions $X_1, \ldots, X_w$ of O_x and $Y_1, \ldots, Y_h$ of O_y. The partitions $X_1, \ldots, X_w$ are sorted according to O_y and the partitions $Y_1, \ldots, Y_h$ according to O_x.

At step 420, the pixel in the lower-left corner is placed (e.g., position (1,1), of the sub-group). In one embodiment, the pixel is placed according to Equation 1:

Equation 1

$$f^{-1}(1,1) = \left\{ d_s \mid \min_{d_s \in X_1} \{d_s.a_2\} = \min_{d_s \in Y_1} \{d_s.a_1\} \right\}$$

At step 430, all pixels in the lower pixel row and the left pixel row of the sub-group are placed. In one embodiment, the lower pixel row is placed according to Equation 2:

Equation 2